Generalized Gibbs ensemble in nonintegrable systems with an extensive number of local symmetries

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Recent experimental realizations of almost isolated quantum systems have encouraged theorists to study dynamics that follow unitary time-evolution. One of the important topics is whether systems approach stationary states that are described by the canonical ensemble. In nonintegrable systems that conserve energy alone, the canonical ensemble is justified by the eigenstate thermalization hypothesis (ETH). On the other hand, in integrable systems or systems that show many-body localization, the stationary state cannot be described by the canonical ensemble because of nontrivial conserved quantities.

The generalized Gibbs ensemble (GGE) is a promising candidate for describing stationary states in integrable systems. The applicability of the GGE is verified for systems whose Hamiltonian can be mapped to a quadratic form or solved by Bethe ansatz. These integrable systems have sets of conserved quantities from which each energy eigenstate can be identified.

To clarify the importance of conserved quantities for the appearance of non-thermal stationary states, it is interesting to study models with less numbers of conserved quantities than the usual integrable systems. Previous studies showed two extreme cases: the stationary state seems to be described by the canonical ensemble if the system conserves only energy, and the GGE is necessary when sufficiently many conserved quantities exist so that every eigenstate is identified. Then, how many conserved quantities should systems possess for the appearance of the stationary states that are described by the GGE?

In this talk, we show that the stationary state is described by the GGE if the system has an extensive number of local symmetries, even when it is a nonintegrable system. We have investigated a nonintegrable model of hard-core bosons with an extensive number of local Z2 symmetries. We show that the expectation values of macroscopic observables in the stationary state are described by the GGE rather than the canonical ensemble. In this case, the usual ETH does not hold true. Instead, the ETH for each symmetry sector, which we call the restricted ETH (rETH), holds true. We argue that the rETH plays an important role for our system to approach the GGE. We have also examined models that have less numbers of local Z2 symmetries. We show that the canonical ensemble well describes the stationary states and that we do not have to use the GGE for these two models.

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